



Taxonomical and ecological aspects of the nudibranch *Geitodoris patagonica* Odhner, 1926 (Opisthobranchia, Doridina) from Argentina

Claudia Muniain

KEY WORDS: Gastropoda Nudibranchia, *Geitodoris patagonica*, taxonomy, redescription, chemical ecology, Argentina.

ABSTRACT *Geitodoris patagonica* Odhner, 1926 is redescribed based on the study of numerous specimens collected from Patagonia (Argentina). The external coloration, radular morphology and reproductive system are examined. The defensive behaviour is investigated comparing it to the mechanical and chemical strategies recently found in other Magellanic dorid nudibranchs. The record of *G. pusae* (Marcus, 1955) from Argentina, and the synonymy of *G. patagonica* with *G. falklandica* Odhner, 1926 are discussed. The taxonomical and ecological results are discussed and compared to other *Geitodoris* species, principally those present in the Atlantic Ocean..

RIASSUNTO *Geitodoris patagonica* Odhner, 1926 viene ridescritta in base allo studio di numerosi esemplari raccolti in Patagonia (Argentina), esaminando la colorazione esterna, la morfologia radulare ed il sistema riproduttivo.

Il comportamento difensivo viene studiato confrontandolo con le strategie meccaniche e chimiche messe in atto da altri doridacei magellani.

I risultati tassonomici ed ecologici sono confrontati e discussi con quelli relativi alle altre specie di *Geitodoris*, soprattutto quelle presenti nelle acque atlantiche..

C. MUNIAIN Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" Avda. Angel Gallardo 470 (C1405DJR). Buenos Aires. Argentina, e-mail: muniain@muambe.gov.ar

INTRODUCTION

The genus *Geitodoris* Bergh, 1891 was created for species whose lacking a differentiated prostate and having two types of lateral teeth, the inner ones hooked and the outer ones spatulated. Recently, MILLER (1996) described a new species of *Geitodoris* from New Zealand, reviewing the classification of the genus and clarifying the relationships with the genus *Discodoris* Bergh, 1877.

The nudibranch *Geitodoris patagonica* was described by ODHNER (1926) from Puerto Madryn (Chubut, Argentina) and has not been redescribed since its original description. Several authors (CARCELLES, 1950; CARCELLES & WILLIAMSON, 1951; CASTELLANOS, 1970; ORTEA & BALLESTEROS, 1981; PERRONE, 1992; MILLER, 1996) considered this species as valid, within the genus *Geitodoris* from the Western Atlantic. However, these authors did not examined the type material or newly collected specimens.

Three species belonging to the genus *Geitodoris* Bergh, 1891 have been recorded from the South Atlantic: *G. patagonica* Odhner, 1926 (from Patagonia, Argentina); *G. falklandica* Odhner, 1926 (from the Falklands Islands) and *G. pusae* (= *Discodoris pusae* Marcus, 1955) (from Florida to Argentina 40° 56'S). The species *Discodoris pusae* was transferred to *Geitodoris* and considered as an amphiatlantic species by ORTEA & BALLESTEROS (1981), and ORTEA, LUQUE & TEMPLADO (1988).

Following the studies on defensive behaviour recently investigated in Magellanic opisthobranchs (MUNIAIN, 1997; FONTANA ET AL, 1998; GAVAGNIN ET AL, 1999; MUNIAIN ET AL, 1999), the mechanic and chemical defensive strategies found in Magellanic dorid nudibranchs are compared to those present in *G. patagonica*.

The present paper contributes to the taxonomic redescription of this species, based on living animals, and new results on ecological aspects of *Geitodoris patagonica* from Argentina.

MATERIAL AND METHODS

Since 1991, numerous specimens of *G. patagonica* have been collected from Patagonian localities (Argentina), in intertidal rock pools and by scuba diving (2-5 m depth). For all the specimens, the total length alive was measured, and information on the coloration, diet, reproductive behaviour, was taken. The radula, jaws and mantle (critically point dried) were examined using scanning electron microscope (SEM). In several specimens, the buccal secretions were tested with pH indicator strips (pH: 0-14) at the moment of collection. The chemical analysis was made at the Istituto per la Chimica di Molecole di Interesse Biologico (Naples, Italy), where the frozen animals were dissected. The mantle, foot and digestive gland were isolated, and extracted with acetone. Each extract was chromatographed on silica gel plates in chloroformethanol, and later checked for fluorescent compounds by exposure under UV.

A voucher specimen is deposited at Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", MACN: 34257. 1 specimen 42 mm long (Not dissected). 31 December 1994, Punta Marques (Chubut).

RESULTS SYSTEMATICS

Suborder Doridina

Superfamily Eudoridoidea

Family Dorididae Rafinesque, 1815

Genus *Geitodoris* Bergh, 1891

Geitodoris patagonica Odhner, 1926
(Figs. 1- 5)

Geitodoris patagonica Odhner, 1926: 80-81, pl. 3, figs. 42-43; Carcelles, 1950: 70, pl. 3, fig. 56; Carcelles and Williamson, 1951: 316; Muniain, 1997: 24, fig. 1 3C.

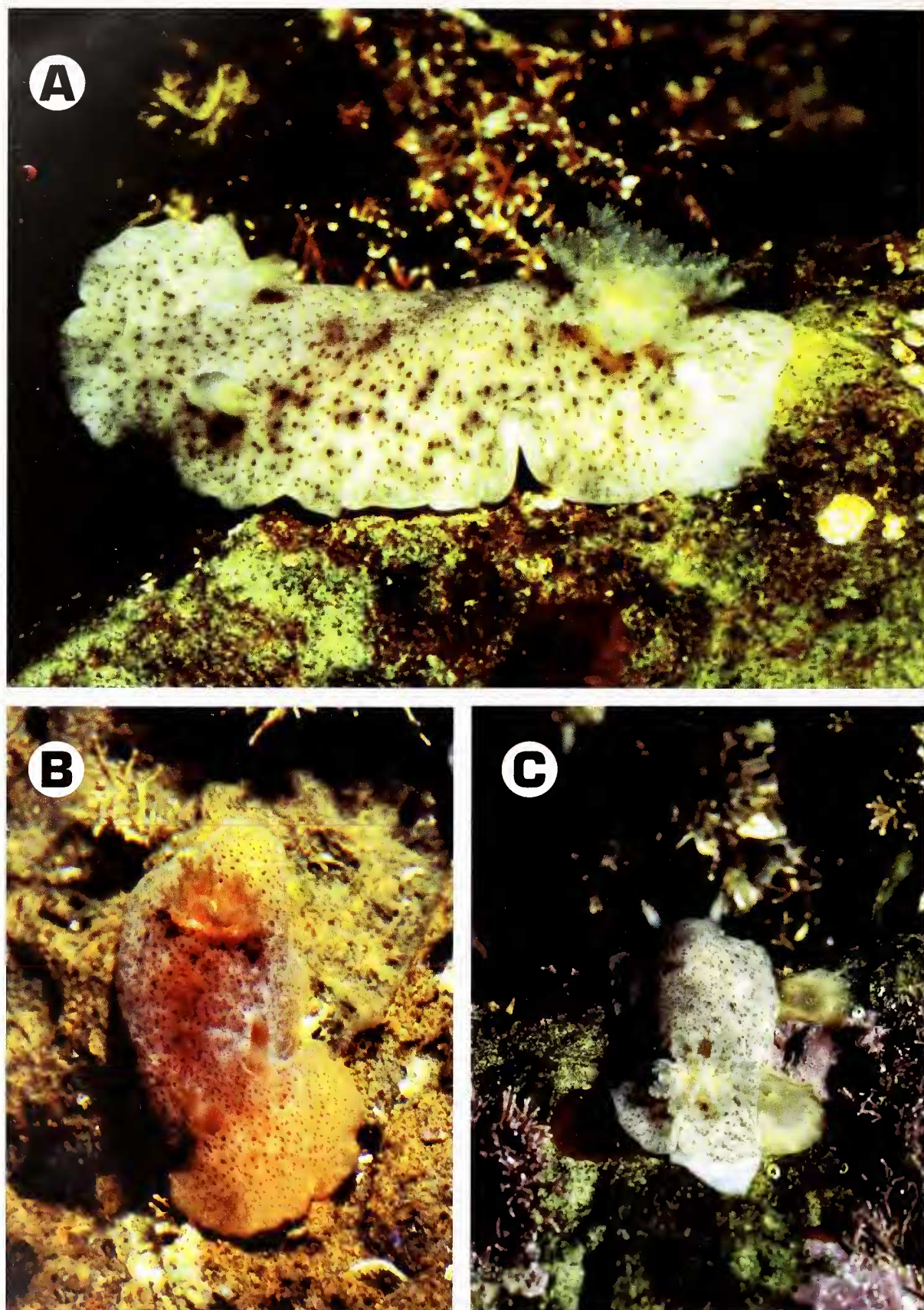


Figure 1: *Geitodoris patagonica* living animals from Rada Tilly (Chubut). Photograph by Claudia Muniain. A. Specimen showing the white pattern spotted with black dots. B. Specimen showing the yellow pattern. C. Dorsal view of the same specimen A, showing the branchial crown and the foot extending posteriorly.



Geitodoris patagonicus (non Carcelles, 1944: 264); Castellanos, 1970: 148, pl. 11, fig. 8; Scarabino, 1977: 195, pl. 1, fig. 10.

Geitodoris falklandica Odhner, 1926: 83, pl. 3, figs. 44-46; Carcelles, 1950: 70, pl. 3, fig. 59; Carcelles and Williamson, 1951: 315; Muniain, 1997: 24.

Geographic Range: From Northern Chubut to Falklands Islands (Magellanic Province).

Type Locality: Puerto Madryn, Chubut (42° 30'S).

External morphology

Body length up to 30-50 mm. The background colour of the body varies from white, yellow-orange to dark grey, spotted with black dots on the dorsum (Fig. 1 A-C). The coloration has no relation with the animal length or state of maturity. The surface of the mantle, the border of the rhinophoral and branchial sheaths are densely covered with two sizes of low and rounded tubercles. Only, from the smallest and numerous tubercles there are spicules projecting apically in number of 6-10 (observed by SEM, Fig. 2 A-B). The rhinophores are pale to yellow-cream ending in translucent tips, perfoliate with 12 to 18 lamellae. The gill has the same colour as the dorsum, spotted with black dots. There are 6-8, bi or tripinnate branchial leaves. The anal papilla lies central within the cirlet of the branchial plume. Ventrally, the foot is narrow, completely white and extends posteriorly (Fig. 1 B). The anterior border of the foot is bilabiate and notched. The head is rounded and the oral tentacles are broad.

Internal Anatomy

The radular formula is 16-20 x 12.28.0.28.12 in a 46 mm alive specimen. The innermost lateral tooth is hook shaped (Fig. 3A, D). The mid lateral teeth have a small, recurved, pointed cusp, that increases in length to the end of the row (Fig. 3B, C). The 7-10 outermost lateral teeth are spatulated and are similar in length to the mid laterals (Fig. 3B). The teeth are completely smooth, lacking denticles or a serrate border. The jaw plates are well developed showing the same regular rodlets in the each side, above and below (Fig. 4A,B).

There is a conspicuous and pigmented blood gland on the oral tube. The stomach is covered with the digestive gland (Fig. 5A). The reproductive system has a long and tubular ampulla, the spherical gametolytic gland and the seminal receptacle are situated under the long vas deferens. A yellowish and elongated prostate is present. The penis is conical and unarmed. The vagina is long and narrow, a vaginal gland is present (Fig. 5B).

Ecology

Three different patterns of background coloration, spotted with black dots, were found: orange-yellow, grey-dark and white. This seems to be related to the substratum in which each specimen was lying (sponges, dark or light rocks). This defensive mechanism in which the animal resembles the uniform coloration of its background is named as crypsis: homochromy (ROS, 1976; TODD, 1981).

Part of the specimens collected were removed and frozen as soon as possible after collection, and some of them were disturbed to obtain defensive secretions. The secretions were tested with pH indicator strips, showing acid secretion (pH: 0-1).

In other biochemical studies of Magellanic nudibranchs that we

have recently recorded and investigated from Argentina (MUNIAIN ET AL, 1996; MUNIAIN, 1997), we found that the species *Tyrinna nobilis* contains a number of terpenoids, obtained from the diet and stored in the mantle dermal formations (MDFs) and, in the species *Anisodoris fontainii* a series of diacylglycerols were isolated from their mantle. These natural products, as secondary metabolites, are supposed to play a defensive role in these species (FONTANA ET AL, 1998; GAVAGNIN ET AL, 1999; MUNIAIN ET AL, 1999).

Geitodoris patagonica lives in the same habitat and eats sponges as the species mentioned above, but no evidence of active metabolites has been found in the extract from the digestive gland, mantle and secretions. On the contrary, the inorganic acid secretions from the mucus has only been found in this species. Three defensive mechanisms are probable presents in *G. patagonica*: mechanical (homochromy and endoskeletal calcareous spicules) and chemical strategies (inorganic acid secretions).

DISCUSSION

The present work does not take into consideration the division of the genus *Geitodoris* into three subgenera by ORTEA & BALLESTEROS (1981), because the species *G. patagonica* and *G. falklandica* have not been included in the list of the species studied, and a complete phylogenetic analysis clarifying this matter is necessary. The family is enumerated in order of the classification followed by RUDMAN & WILLAN (1998).

ODHNER (1926), distinguished *G. patagonica* and *G. falklandica*, based on the external coloration, the morphology and number of radular teeth, the mantle tubercles and the skin porosity. The present study shows that there is a large variation in the external coloration, therefore this is not a good comparative character. The same occurs with the porosity of the mantle, which it is probably related to the different temperature conditions. There are no significant differences between the reproductive system and radula mentioned in the original descriptions of these two species, therefore these species should be considered synonyms, and the geographic range of *G. patagonica* extended to the Falkland Islands.

Unfortunately, a great confusion has existed on the records of the opisthobranchs from Argentina, where most identifications were made based on reviews of the original descriptions, without a revision of the types or comparative material (CARCELLES, 1950; CARCELLES Y WILLIAMSON, 1951; CASTELLANOS, 1970).

MUNIAIN (1997) discussed the record of *Geitodoris patagonica* from the Argentinean Province stated by CARCELLES (1944: 264, as *G. patagonicus*), who doubtfully assigned to this species a specimen collected from Puerto Quequén (Buenos Aires), and which did not fit to the original description and figure given by ODHNER (1926). Surprisingly, my own examination of Carcelles's specimen (MACN: 18505) demonstrated that it is actually an aeolid nudibranch (incorrectly assigned or mislabelling?). Therefore, I suggest that *G. patagonica* has not been recorded from that latitude, and so far, its geographic range is restricted to the Magellanic Province.

SCARABINO V. (1977) assigned to *Geitodoris patagonica* (as *G. patagonicus*) the specimens collected at 36 and 90 m depth in Golfo San Matías. It is impossible to confirm the validity of this record because there is no material deposited or description of the specimens, and the drawing included is to confusing (SCARABINO, 1977: pl. 1, fig. 10).

MUNIAIN (1997) cited and included a colour photograph of *G.*

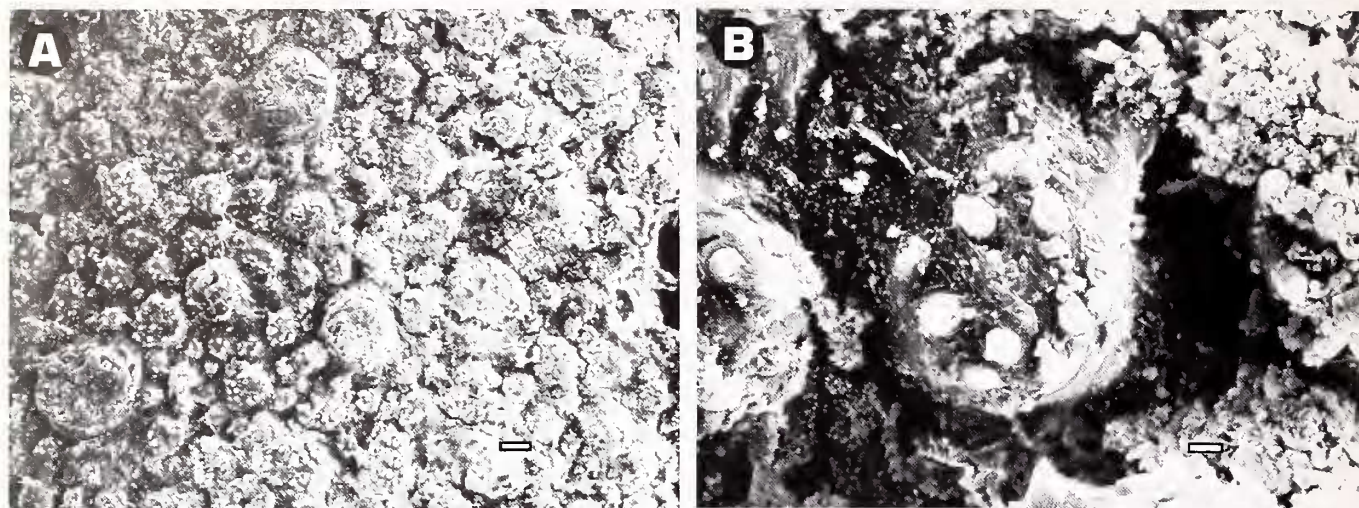


Figure 2: *Geitodoris patagonica*, scanning electron micrographs. Mantle. A. Low-magnification view of mantle tubercles. Scale bar: 100 µm. B. Detail of a single tubercle with apically projecting spicules. Scale bar: 10 µm.

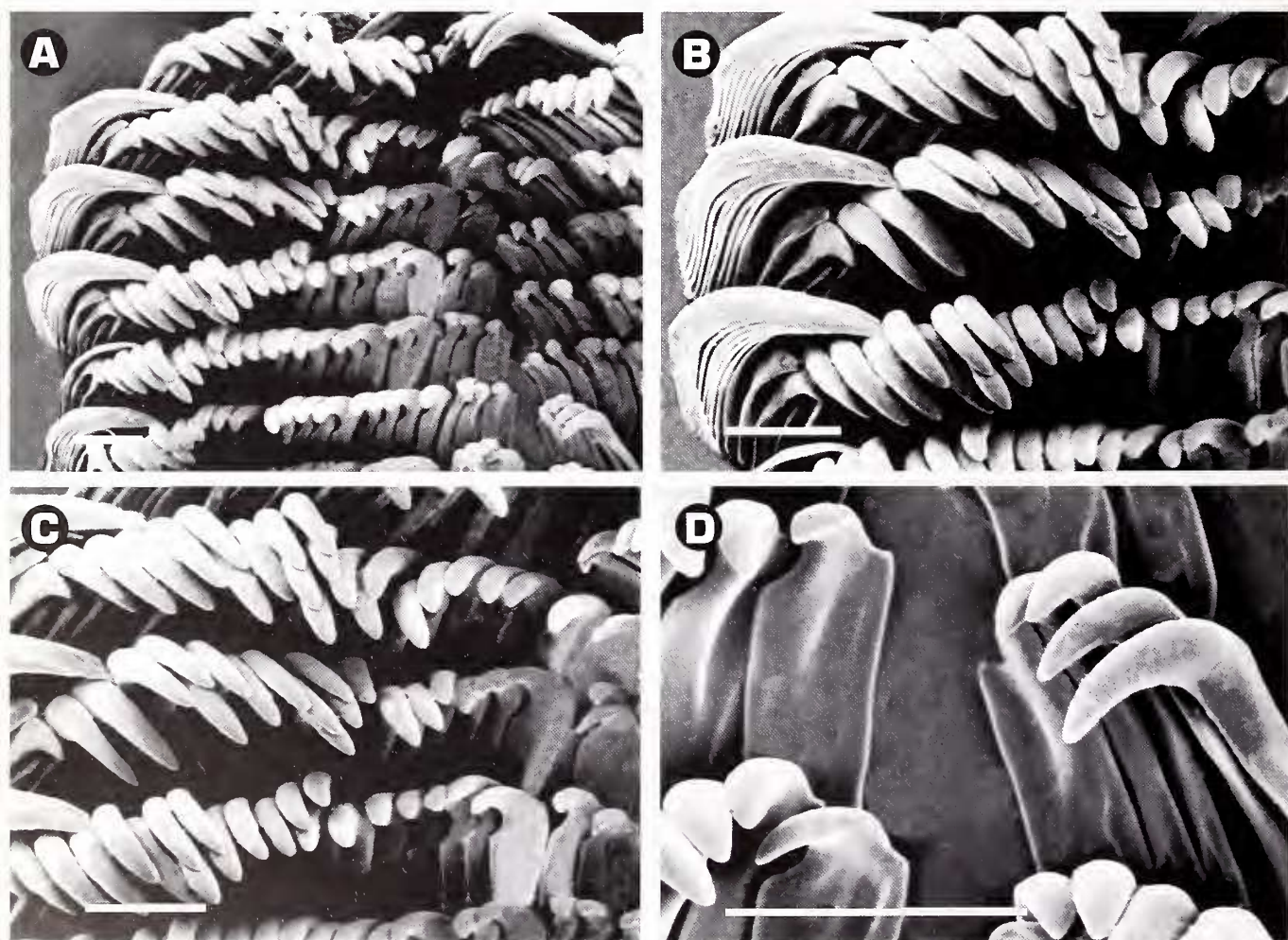


Figure 3: *Geitodoris patagonica* scanning electron micrographs. Radula. A. Half row of radular teeth. B. Outermost spatulated teeth and mid lateral teeth. C. Mid lateral teeth bearing recurved pointed cusp. D. Detail of the innermost hooked lateral teeth. Scale bar: 100 µm.



patagonica from Chubut and the distribution for this species was extended to northern Santa Cruz.

The record of the amphiatlantic species *Geitodoris pusae* Marcus, 1955 by MARCUS & MARCUS (1969), from Northern Argentina, seems to be valid, considering as consistent and separable characters of this species the presence of a reticulate mantle and the spicules in the external duct of the vestibular gland (see MARCUS & MARCUS, 1969; ORTEA ET AL, 1988; Fig. 9).

The other Atlantic species of *Geitodoris*, such as *Geitodoris planata* (Alder & Hancock, 1846), *G. reticulata* Eliot, 1906, *G. bonosi* Ortea & Ballesteros, 1981, *G. perfossa* Ortea, 1990, and *G. bacalladoi* Ortea, 1990, are clearly distinguishable from *G. patagonica* by the distribution of the spotted black dots, radular and jaw morphology, serrated border teeth, and the presence of reticulated or spherical calcareous structures on the mantle (ORTEA & BALLESTEROS, 1981; CERVERA ET AL, 1985; ORTEA, 1990; MARTÍNEZ ET AL, 1996).

Acid defensive secretions are common among opisthobranchs, and particularly in dorid nudibranchs (THOMPSON, 1960; EDMUNDS, 1968; TODD, 1981). ÁVILA (1995) compiled a catalogue of natural products and secretions in species of opisthobranch. According to this study, the absence of secondary metabolites and the presence of acid secretion (inorganic acids) in *Geitodoris patagonica* also occurs in the species *Geitodoris portmanni*, *Discodoris beathi*, *D. palma*, *D. pusae*, *D. stellifera* and *D. tema*. Once again, there is a close relationship between species of *Geitodoris* and *Discodoris*. See the revision by Miller (1996) about the morphological similarities into these genera.

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ADDENDUM

While this manuscript was in press, the paper by Schrödl (2000) entitled "Revision of dorid Nudibranchia collected during the French Cape Horn Expedition in 1882-1883, with discussion of the genus *Geitodoris* Bergh, 1891" was published in *The Veliger* 43: 197-209. In this paper, the species *Geitodoris patagonica* is revised taxonomically.

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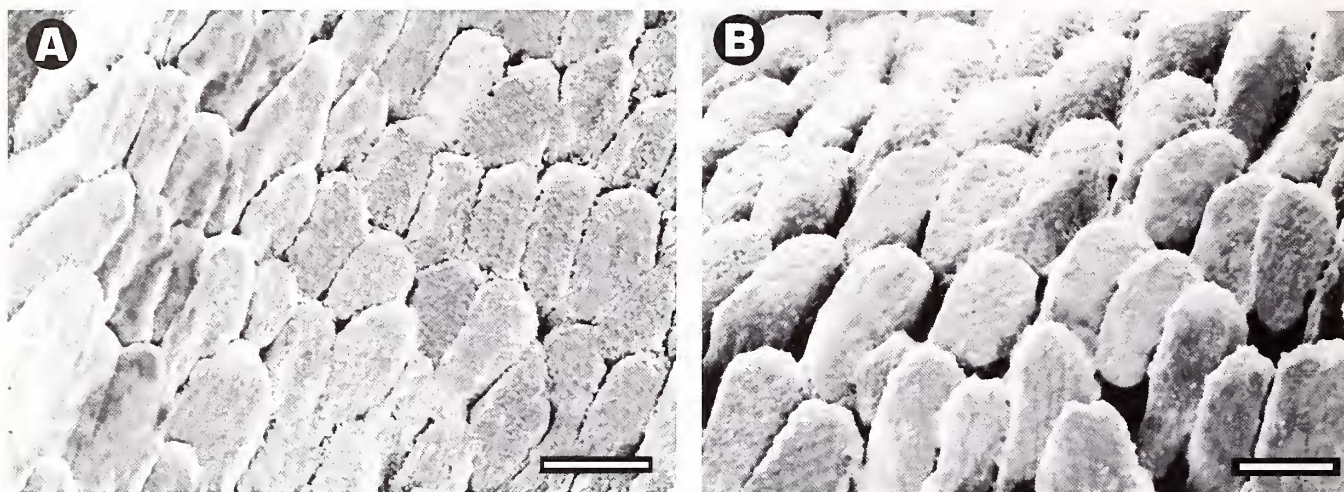


Figure 4: *Geitodoris patagonica*, scanning electron micrographs. Jaws. A. Labial rodlets, group of the right above side. B. Labial rodlets, group of the right below side. Scale bar: 20 μ m.

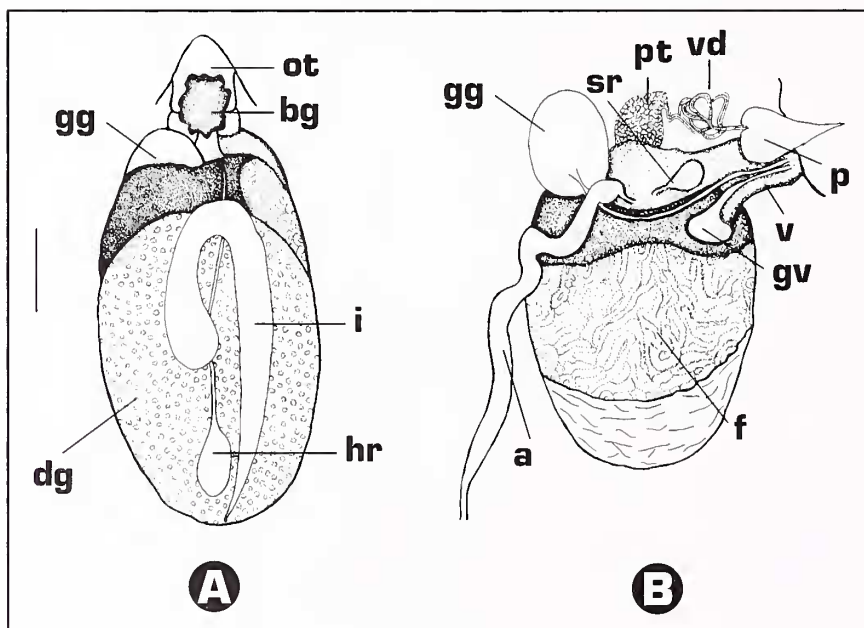


Figure 5: *Geitodoris patagonica*, A. Internal anatomy. B. Reproductive system. Abbreviations: a: ampulla, bg: blood gland, dg: digestive gland, f: female glandular mass, gg: gametolytic gland, gv: vaginal gland, hr: heart, i: intestine, ot: oral tube, p: penis, pt: prostate, sr: seminal receptacle, v: vagina, vd: vas deferens. Scale bar: 2 mm